Anomalies In The β decay Processes And The Pulse Strong-Current Discharges As Consequence Of Electron Gravitational Emission

S.I. Fisenko

Kazakh State University, Physics Department
Al Farabi str., 71, 480078 Almaty, Kazakhstan
E-mail: altair_alm@hotmail.com

Abstract

Parity nonconservation in the β decay processes is considered as fundamental property of weak interactions. Nevertheless, this property can be treated as anomaly, because in fundamental interactions of the rest types parity is conserved. Analogously, anomaly in the short-duration strong-current pulse discharges is well known. The essence of this phenomenon consists in generation of local high-temperature plasma formations (LHTF) with the typical values of its thermodynamical parameters exceeding those related to the central section of a discharge. In this paper, an attempt is undertaken to treat these anomalies as manifestation of fundamental properties of gravitational emission. Some consequences of this assumption can be tested in the β decay experiments as well as in the experiments with short- duration z-pinch-type pulse discharges.

1 Quantum-Level Gravitational Interaction, Limiting Transition to GRT

Two points are of importance for the model considered. (1) In the Einstein field equations κ is a constant that relates geometric properties of the space-time to the distribution of physical matter, and origin of the equations isn't associated with numerical restriction imposed on the constant κ . However, the correspondence principle (requirement of correspondence between the Relativistic Theory of Gravity and the Newtonian Classic Theory of Gravity) leads to small value of the constant $\kappa = 8\pi G/c^4$, where G and c are, respectively, the Newtonian gravitational constant and the velocity of light. The correspondence principle follows from the primary concept of the Einstein GTR treated the latter as relativistic generalisation of the Newtonian Theory of Gravity. (2) Equations which incorporate the Λ term are the most general ones in the Relativistic Theory of Gravity. The limiting transition to weak fields leads to the equation:

$$\Delta\Phi = -4\pi\rho G + \Lambda c^2,$$

(here Φ is the field scalar potential, ρ is the source density), rather than to the Poisson equation. This fact, finally, is crucial when neglecting the Λ -term, because only in this case GTR can be considered as generalised Classic Theory of Gravity. Thus, numerical values of the quantities $\kappa = 8\pi G/c^4$ and $\Lambda = 0$ in the GTR aren't associated with origin of equations but originate only from correspondence between GRT and the appropriate classic theory. Beginning with seventies, it has become clear [1] that in the quantum region the numerical value of the constant G isn't compatible with principles of Quantum Mechanics. In a number of papers ([1], [2]) it was shown that in the quantum region the coupling constant K is more accessible ($K \approx 10^{40}G$). So the problem of quantum-level generalisation of relativity equations was reduced to matching the numerical values of gravity constants in the quantum and classic regions. As a development of these results concerning the micro-level approximation of the Einstein field equations, a model is proposed under the following assumption:

The gravitational field within the region of localisation of an elementary particle having a mass m_0 is characterised by the values of the gravity constants K and Λ that lead to stationary states of the particle in its proper gravitational field, and the particle stationary states are the sources of the gravitational field with the Newtonian gravity constant G.

In the frame of the Gravity Theory the most general approach takes twisting into account and treats the gravitational field as the gauge one, considered similar to other fundamental fields [3]. This approach is get rid of a priory grounds as applied to geometrical properties of the gravitational field, and it seems to be reasonable at a microscopic level. For the elementary source of a mass m_0, the equation set describing its states in the proper gravitational field, according to the accepted assumption, looks like this:

$$\left\{ i\gamma^\mu \left(\nabla_\mu + \bar{\kappa}\Psi\gamma_\mu\gamma_5\Psi\gamma_5 \right) - m_0 c/\hbar \right\} \Psi = 0 \tag{1}$$

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = -\kappa \left\{ T_{\mu\nu}(E_n) - \mu g_{\mu\nu} + (g_{\mu\nu}S_\alpha S^\alpha - S_\mu S_\nu) \right\} \tag{2}$$

$$R\left(K, \Lambda, E_n, r_n \right) = R\left(G, E'_n, r_n \right) \tag{3}$$

$$\left\{ i\gamma^\mu\nabla_\mu - m_n c/\hbar \right\} \Psi' = 0 \tag{4}$$

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = -\kappa' T_{\mu\nu}\left(E'_n \right) \tag{5}$$

The following notations are used throughout the article: $\kappa = 8\pi K/c^4$, $\kappa' = 8\pi G/c^4$, E_n is the stationary state energy in the proper gravitational field with the constant K, $\Lambda = \kappa\mu$, r_n is the value of the co-ordinate r, satisfying the equilibrium n state in the proper gravitational field, $\bar{\kappa} = \kappa_0\kappa$, κ_0 is the dimensionality constant, $S_\alpha = \bar{\Psi}\gamma_\alpha\gamma_5\Psi$, $\nabla\mu$ is the spinor- coupling covariant derivative independent of twisting, E'_n is the energy state of the particle having a mass m_n (either free of field or being in the external field) and described by the wave function Ψ', in the proper gravitational filed with the constant G. The rest notations are generally known in the Gravity Theory.

Equations (1) through (5) describe the equilibrium states of a particle (stationary states) in its proper gravitational field and determine the localisation region of the field characterised by constant K that satisfies the equilibrium state. These stationary states are the sources of the field with the constant G, and the condition (3) provides matching the solutions with the constants K and G. The proposed model is compatible with Quantum Mechanics principles, and gravitational field with the constants K and Λ at a certain, quite definite distance specified by the equilibrium state transforms to the filed having the constant G and satisfying, in the weak field limit, the Poisson equation.

A set of equations (1) through (5), first of all, is of interest for the problem of stationary states, i.e., the problem of energy spectrum calculations for elementary source in gravitational field. Here it seems to be reasonable to use analogy with electrodynamics, in particular, with the problem of electron stationary states in the Coulomb field. Transition from the Schrödinger equation to the Klein-Gordon relativistic equations allows to take into account fine structure of the electron energy spectrum in the Coulomb field, whereas transition to the Dirac equation

allows to take into account relativistic fine structure and the energy level splitting associated with spin-orbital interaction. Using this analogy and appearance of the equation (1), one can conclude that solution of this equation without the term $\bar{\kappa}\bar{\Psi}\gamma_\mu\gamma_5\Psi\gamma_5$ results in the spectrum similar[1] to that of fine structure. As for the term $\bar{\kappa}\bar{\Psi}\gamma_\mu\gamma_5\Psi\gamma_5$, as it was already marked in Ref. 1, its contribution is similar to that of the term $\bar{\Psi}\sigma^{\mu\nu}\Psi F_{\mu\nu}$ in the Pauli equation. The latter implies that solution of the problem of stationary states with twisting taken into account will give total energy-state spectrum with both relativistic fine structure and energy state splitting caused by spin-twist interaction taken into account. This fact, being in complete correspondence with requirements of Gauge Theory of Gravity, forces us to believe that the above-stated assumptions on properties of gravitational field in the quantum region refer, in general, rightly to the gravitational field with twists. Due to complexity of solving this problem, we have use a simpler approximation, namely: energy spectrum calculation in relativistic fine-structure approximation. In this approximation the problem of the elementary source stationary states in the proper gravitational field is reduced to solving the following equations:

$$f'' + \left(\frac{\nu' - \lambda'}{2} + \frac{2}{r}\right) f' + e^\lambda \left(K_n^2 e^{-\nu} - K_0^2 - \frac{l(l+1)}{r^2}\right) f = 0 \tag{6}$$

$$-e^{-\lambda}\left(\frac{1}{r^2} - \frac{\lambda'}{r}\right) + \frac{1}{r^2} + \Lambda = \beta(2l+1)\left\{f^2\left[e^{-\lambda}K_n^2 + K_0^2 + \frac{l(l+1)}{r^2}\right] + f'^2 e^{-\lambda}\right\} \tag{7}$$

$$-e^{-\lambda}\left(\frac{1}{r^2} + \frac{\nu'}{r}\right) + \frac{1}{r^2} + \Lambda = \beta(2l+1)\left\{f^2\left[K_0^2 - K_n^2 e^{-\nu} + \frac{l(l+1)}{r^2}\right] - e^\lambda f'^2\right\} \tag{8}$$

$$\left\{-\frac{1}{2}\left(\nu'' + \nu'^2\right) - (\nu' + \lambda')\left(\frac{\nu'}{4} + \frac{1}{r}\right) + \frac{1}{r^2}(1 + e^\lambda)\right\}_{r=r_n} = 0 \tag{9}$$

$$f(0) = const \ll \infty \tag{10}$$

$$f(r_n) = 0 \tag{11}$$

$$\lambda(0) = \nu(0) = 0 \tag{12}$$

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[1]in terms of relativism and removal of degeneracy by general quantum number

$$\int\limits_{0}^{r_n} f^2 r^2 dr = 1 \tag{13}$$

Equations (6)–(8) follow from the equations (14)-(15)

$$\left\{ -g^{\mu\nu} \frac{\partial}{\partial x_\mu} \frac{\partial}{\partial x_\nu} + g^{\mu\nu} \Gamma^\alpha_{\mu\nu} \frac{\partial}{\partial x_\alpha} - K_0^2 \right\} \Psi = 0 \tag{14}$$

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -\kappa \left(T_{\mu\nu} - \mu g_{\mu\nu} \right), \tag{15}$$

after substitution of Ψ in the form: $\Psi = f_{El}(r) Y_{lm}(\vartheta, \varphi) exp\left(\frac{-iEt}{\hbar}\right)$ and specific computations in the central-symmetry field metric with the interval determined by the expression [4]

$$dS^2 = c^2 e^\nu dt^2 - r^2 \left(d\vartheta^2 + sin^2\vartheta d\varphi^2 \right) - e^\lambda dr^2 \tag{16}$$

he following notations are used above: f_{El} is the radial wave function that describes the states with a definite energy E and the orbital moment l (bellow the indices l are omitted), $Y_{lm}(\vartheta, \varphi)$ are spherical functions; $K_n = E_n/\hbar c$, $K_0 = cm_0/\hbar$, $\beta = (\kappa/4\pi)(\hbar/m_0)$. The condition (9) determines r_n; whereas equations (10) through (12) are the boundary conditions and the normalisation condition for the function f respectively. The general form of the equation (9) is as follows: $R(K, r_n) = R(G, r_n)$. In neglect of the proper gravitational field with constant K, we can re-write this condition as $R(K, r_n) = 0$, going to the equality (9).

R.h.s of Eqs. (7)–(8) are calculated on a base of general expression for the energy-momentum tensor of the complex scalar field:

$$T_{\mu\nu} = \Psi^+_{,\mu} \Psi_{,\nu} + \Psi^+_{,\nu} \Psi_{,\mu} - \left(\Psi^+_{,\mu} \Psi^{,\mu} - K_0^2 \Psi^+ \Psi \right) \tag{17}$$

The appropriate components $T_{\mu\nu}$ are obtained by summation over the index m with application of the characteristic identities of spherical functions [5] on substituting $\Psi = f(r) Y_{lm}(\vartheta, \varphi)$ $exp\left(\frac{-iEt}{\hbar}\right)$ to Eq. (17). Even in the simplest approximation the problem of the elementary source stationary states in the proper gravitational field is a complicated mathematical problem. It is getting simpler is one restricts himself by estimation of the energy spectrum. Eq. (6) can be reduce to the equations [6]:

$$f' = fP(r) + Q(r)z \qquad z' = fF(r) + S(r)z \tag{18}$$

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This transition implies specific choice of P, Q, F, S with satisfaction of the conditions:

$$P + S + Q'/Q + g = 0 \qquad FQ + P' + P^2 + Pg + h = 0 \tag{19}$$

where g and h correspond to Eq. (6) written in the form: $f'' + gf' + hf = 0$. The conditions (19) are satisfied, in particular, by P, Q, F, S written as follows:

$$Q = 1, \qquad P = S = -g/2, \qquad F = \frac{1}{2}g' + \frac{1}{4}g^2 - h \tag{20}$$

Solutions of the set (18) are the functions [6]:

$$f = C\rho(r)\sin\vartheta(r) \qquad z = C\rho(r)\cos\vartheta(r) \tag{21}$$

where C is an arbitrary constant, $\vartheta(r)$ is the solution of the equation:

$$\vartheta' = Q\cos^2\vartheta + (P - S)\sin\vartheta\cos\vartheta - F\sin^2\vartheta, \tag{22}$$

and $\rho(r)$ is determined by the formula

$$\rho(r) = exp \int_0^r \left[P\sin^2\vartheta + (Q + F)\sin\vartheta\cos\vartheta + S\cos^2\vartheta \right] dr. \tag{23}$$

In this case, the form of solution presentation in polar co-ordinates allows to determine zeros of the functions $f(r)$ at $r = r_n$, with correspondent values of $\vartheta = n\pi$ (n is an integer). As one of the simplest approximations for ν, λ , let's choose the dependence:

$$e^\nu = e^{-\lambda} = 1 - \frac{\tilde{r}_n}{r + C_1} + \Lambda(r - C_2)^2 + C_3 r \tag{24}$$

where $\tilde{r}_n = \frac{2Km_n}{c^2} = \frac{2KE_n}{c^4} = \left(\frac{2K\hbar}{c^3} \right) K_n$, $C_1 = \frac{\tilde{r}_n}{\Lambda r_n^2}$, $C_2 = r_n$, $C_3 = \frac{\tilde{r}_n}{r_n(r_n + C_1)}$

Earlier the estimate for K was adopted as $K \approx 1.7 \times 10^{29}$ Nm^2kg^{-2}. If one assumes that the observed value of the electron rest mass m_1 is its mass in the ground stationary state in the proper gravitational field, then $m_0 = 4m_1/3$. From dimensionality reasoning it follows that the coupling energy is determined by the expression $\left(\sqrt{K}m_0 \right)^2 /r_1 = 0.17 \times 10^6 \times 1.6 \times 10^{-19}$J, where r_1 is the electron classic radius. Then we obtain the following estimate: $K \approx 5.1 \times 10^{31} Nm^2kg^{-2}$, which is used later as the initial one. Discrepancies in the estimates for K, obtained by various ways, are quite admissible, still, being not of catastrophic character. From the fact that μ is the electron energy density it follows: $\mu = 1.1 \times 10^{30} J/m^3$, $\Lambda = \kappa\mu = 4.4 \times 10^{29}$ m^{-2}. From Eq. (22) it follows[2]:

$$2\vartheta' = (1 - \bar{F}) + (1 + \bar{F})\cos2\vartheta \approx (1 - \bar{F}) \tag{25}$$

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[2] with the equation for $f(r)$ taken into account

where $\bar{F} = \frac{1}{2}\bar{g}' + \frac{1}{4}\bar{g}^2 - \bar{h}$, $\bar{g} = r_n\left(\frac{2}{r} + \frac{(\nu' - \lambda')}{2}\right)$, $\bar{h} = r_n^2 e^{\lambda}\left(K_n^2 e^{-\nu} - K_0^2 - \frac{l(l+1)}{r^2}\right)$.

Integration of Eq. (25) and substitution of $\vartheta = \pi n$, $r = r_n$ results in the dependence of K_n on r_n

$$
\begin{aligned}
-2\pi n = &-\frac{7}{4} - \frac{r_n K_n^2}{\Lambda^2}\sum_{i=1}^{3}\left\{A_i\left[\frac{(r_n + \alpha_i)^2}{2} - 2\alpha_i(r_n + \alpha_i) + \frac{\alpha_i^3}{(r_n + \alpha_i)} + 2C_1(r_n + \alpha_i)+\right.\right.\\
&\left.+2C_1\frac{\alpha_i^2}{r_n + \alpha_i} + \frac{C_2^2\alpha_i}{r_n + \alpha_i}\right] + B_i\left[(r_n + \alpha_i) + \alpha_i^2\frac{1}{r_n + \alpha_i} + \frac{2C_1\alpha_i}{r_n + \alpha_i} - \frac{C_2^2}{r_n + \alpha_i}\right]\Bigg\} +\\
&+\frac{K_0^2 r_n}{\Lambda^2}\sum_{i=1}^{3}A_i'(r_n + \alpha_i) + \frac{r_n l(l+1)}{\Lambda}\left[d_1 r_n - \frac{C_1 d_2}{r_n} + \sum_{i=1}^{3}\alpha_i(r_n + \alpha_i)\right] -\\
&-\frac{K_n^2 r_n}{\Lambda^2}\left\{\sum_{i=1}^{3}\left[2\alpha_i^2 A_i - 2\alpha_i B_i - 4C_1 A_i\alpha_i + 2C_1 B_i + C_2^2 A_i + \frac{K_0^2\Lambda A_i'}{K_n^2}(\alpha_i - C_1) -\right.\right.\\
&\left.\left.-r_n^2\Lambda l(l+1)\alpha_i\,(C_1 - \alpha_i)\right]\ln(r_n + \alpha_i) - r_n\Lambda^{-1}l(l+1)(d_2 + C_1 d_1)\ln r_n\right\} \quad (26)
\end{aligned}
$$

The coefficients entering Eq. (26) are the factors at simple fractions in the polynomial expansion needed for equation integration, and $\alpha_i \sim K_n$, $d_2 \sim A_i \sim r_n^{-5}$, $B_i \sim r_n^{-4}$, $A_i' \sim r_n^{-2}$, $\alpha_i \sim r_n^{-4}$, $d_1 = r_n^{-4}$. There exists the condition (9) (or the equivalent condition $exp\,\nu(K, r_n) = 1$, used for this approximation) in order to eliminate r_n from Eq. (26). However, direct application of this condition will make the expression (26) still more complicated. And one can readily notice that $r_n \sim 10^{-3} r_{nc}$, where r_{nc} is the Compton wavelength of a particle of the mass m_n, and, hence, $r_n \sim 10^{-3} K_n^{-1}$. The dependence (26) itself is rather approximate; nevertheless, its availability, in spite of the approximation accuracy, implies existence of the energy spectrum, being sequence of particle self-interaction with its proper gravitational field within the range $r \leq r_n$, where mutual compensating actions of the particle and the field take place. With $l = 0$ the approximate solution (26), with the relation between r_n and K_n taken into account, has a form:

$$E_n = E_0\left(1 + \alpha e^{-\beta n}\right)^{-1}, \quad (27)$$

where $\alpha = 1.65$; $\beta = 1.60$

The dependence (27) is specified on a base of the fact that the observed value of the electron mass in rest is the value of its mass in the grounds stationary state in the proper gravitational field, and $r_1 = 2.82 \times 10^{-15} m$, $K_1 = 0.41 \times 10^{12} m^{-1}$ result in the accurate zero of the function, by definition of the numerical values for K and Λ.

Thus, the given numerical estimates for the electron show that within the range of its localisation, with $K \sim 10^{31} N m^2 kg^{-2}$ and $\Lambda \sim 10^{29} m^{-2}$, the spectrum of stationary states in the proper gravitational field exists. .The numerical value of K is, certainly, universal for any elementary source, whereas the value for Λ is determined by the elementary source mass in rest. The distance at which the gravitational field with the constant K is localised is less than the Compton wavelength, comprising for electron the value of an order of its classical radius.

At the distances larger than this one, the gravitational field is characterised by the constant G, i.e., correct transition to Classical GTR holds.

From Eq. (27), roughly, the numerical values of the stationary state energy follow; $E_1 = 0.511\ MeV$, $E_2 = 0.638\ MeV$, ... $E_\infty = 0.681\ MeV$. The quantum transitions over stationary states, allowed by selection rule, must result in the gravitational emission characterised by constant K. The natural widths of transition energies in this spectrum will comprise from 10^{-9} to $10^{-7} eV$. A small value of the energy level width, compared to the electron energy spread in real conditions, explains why the gravitational emission effects aren't observed as by-passers, e.g., in the processes of electron beam bremsstrahlung. If one manages, anyway, satisfying the conditions for excitation of gravitational emission, then availability of large constant of gravity must effect considerably on a state of the emitting system, i.e., the observed effects of gravitational field may turn out far from the traditionally assumed ones.

2 Energy of Gravitational Field As Hidden Energy of Universe

As is known [7], in terms of the Robertson-Worker metric the fundamental equations of Dynamical Cosmology are written as follows[3]:

$$3\ddot{a} = -4\pi G(\rho + 3p)a \tag{28}$$

$$a\ddot{a} + 2\dot{a}^2 + 2k = 4\pi G(\rho - p)a^2 \tag{29}$$

$$\dot{p}a^3 = \frac{d}{dt}a^3(p + \rho) \tag{30}$$

$$p = p(\rho) \tag{31}$$

Equation (30) in Cosmology is treated as the energy conservation law; however, this assertion is to be refined, because this equation is sequence of the Bianki identities $\left(R^{\mu\nu} - \frac{1}{2}g_{\mu\nu}R\right)_{;\nu} \equiv T^{\mu\nu}_{;\nu} = 0$. As for the equations $T^{\mu\nu}_{;\nu} = 0$, it's well known that they aren't the equations of energy-momentum conservation. In accordance with stated above, the particle stationary fields in the proper gravitational field with the constant K serve a role of the source of the gravitational field of an isolated particle with the gravity factor G. The gravitational field energy of a particle with

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[3]in this system of measurement $c=1$

the constant G and the mass m equals the difference between the energy of a particle having the mass in rest m_0 (being a source of the field with the constant K) and energy of a particle having the mass in rest m. Then, evidently, by definition of the gravitational field energy-momentum tensor $t^{\mu\nu}$, it follows that the law of energy-momentum conservation for a particle having the mass m in the gravitational field with the constant G has the form: $(T^{\mu\nu}(m) + t^{\mu\nu})_{,\nu}$. In terms of the Robertson-Worker metric $\Gamma^{\mu}_{ii} = 0$, and, hence, the appropriate identity by Bianki is the energy conservation equation, provided in the energy-momentum tensor for ideal liquid p is replaced by $p_\epsilon = p + \rho_g$, where ρ_g is the energy density of the gravitational field. And it is the focus of refinement of Dynamical Cosmology equations (28) through (31), being very significant because it leads to the relation $\rho_0/\rho_c = 2/(1 + 3\alpha_g)$, where ρ_0 is the substance energy density, ρ_c is the critical value of the substance density, $\alpha_g = \rho_g/\rho$, and the retarding parameter q_0 is set to be equal to unity. The numerical value α_g, e.g., for an electron, equals $1/3$, whereas for nucleons, being in overwhelming majority in the Universe, with its rather complicated structure taken onto account, α_g can have the meaning quite close to unity and even a little bit higher. On the other hand, the numerical value ρ_0/ρ_c In Cosmology is estimated as being within the range from 0.03 to 0.06, and higher [8]. In the course of refinement of the observed meaning for ρ_0 and calculated α_g one should, seemingly, expect that the values of the observed ratio ρ_0/ρ_c and that calculated according to the formula $2/(1 + 3\alpha_g)$ come closer. Thus, in terms of quanta, gravitational interaction leads to existence of considerable fraction of energy in the form of that of the gravitational field, i.e., to presence of hidden mass which should be taken into consideration in the equations of Dynamical Cosmology.

3   Compression of High-Temperature Plasma System by Emitted Gravitational Field

In the dense high-temperature plasma the gravitational emission can occur as a result of electron bremsstrahlung at the nuclei of ion components, i.e., the gravitational emission in this plasma, as well as the electromagnetic one, are the bremsstrahlung emission. Numerical values of the transition energies for stationary states of an electron in the proper gravitational field are, approximately, within the range from 127 to $171 keV$, with the transition energy width value of an order of $10^{-7} eV$, and thats why the gravitational emission in plasma may occur only if its density and temperature are sufficiently high. The recoil energy, as one can readily verify, comprises tens of electron-volts, i.e., resonance absorption of gravitons on nuclei is absent. As the Compton scattering of gravitons on nuclei is insignificant, then it is sufficient to consider the Compton graviton scattering from electrons, being crucial for plasma state in the emitted gravitational field. The frequency of elastic electron-ion collisions in plasma is determined by the well-known expression [9]

$$\nu_{ii} = \frac{1}{6\pi\epsilon_0^2\sqrt{2\pi m}} \frac{e^2 e_i^2 n_i}{(kT_e)^{3/2}} L_e \tag{32}$$

where ϵ_0, T_e, k, n_i, L_e are, respectively, the electric constant, the electron temperature, the Boltsman constant, the ion component concentration and the Coulomb logarithm.

In the simplest approximation, in view of estimation of the value of the electrostatic (intraplasma) field in plasma one can use the expression [10]:

$$E = \frac{e_i}{4\pi\epsilon_0(4\pi n/3)^{-2/3}} \tag{33}$$

where n is the total concentration of plasma. For small values of the internal plasma field intensity the bremsstrahlung gravitational emission (as well as the electromagnetic one) is determined by the appropriate energy of thermal random motion of electrons. As for large values of the internal plasma field intensity (being considered below), it is the value of field intensity crucial in excitation of gravitational emission. In fact, the average value of the kinetic energy of an electron subject to acceleration in the internal plasma field, in accordance with Eqs. (32) through (33), is determined by the expression:

$$\frac{M}{2}\left[\frac{ee_i(4\pi n)^{2/3}(T_e k)^{2/3}6\pi\epsilon_0^2\sqrt{2\pi m}}{4\pi\epsilon_0 \cdot 2M \cdot e^2 e_i^2 n_i L_e}\right]^2 = E_K \tag{34}$$

where M is the electron relativistic mass. Significant increase in the energy density of stationary sates of an electron in its proper gravitational field initiates beginning with $\sim 167 keV$, i.e., the condition for excitation of plasma electron gravitational emission under valuable internal plasma field intensity will have the form:

$$E_K \geq 1.67 \times 1.6 \times 10^{-14} J. \tag{35}$$

Thus, if the plasma parameters reach the values that satisfy the condition (35), then, beginning with this moment of time, in plasma considerable number of elementary acts of gravitational emission take place, although the average value of the energy of thermal random motion of electrons, in neglect of its acceleration by internal plasma field, is lower, at least, by an order of magnitude. The process of the bremsstrahlung gravitational emission, as well as the bremsstrahlung electromagnetic emission, is accompanied by electron scattering. Hence, the cross-section of the bremsstrahlung gravitational emission is represented as the product of probability for graviton emission (as the first-order process) and the electron elastic scattering cross-section. This fact serves as the ground for application of the expression (32) when performing approximate estimation of the excitation conditions for generation of gravitational emission of plasma electrons subject to acceleration in the internal plasma field. Expressions for the cross-section of bremsstrahlung electromagnetic emission, in general case, are very complicated. However, one can use the Born approximation, as the Born cross- section form is rather simple. And although the energy range of interest is far beyond the Born approximation, its application will provide us useful qualitative information concerning the electromagnetic emission intensity. The bremsstrahlung emission cross-section in this approximation is as follows

[11]:

$$\sigma_e = \frac{8}{3}\frac{r_0^2 z^2}{137}\frac{mc^2}{E_0}ln\frac{(\sqrt{E_0}-\sqrt{E_0-\varepsilon})^2}{\varepsilon} \qquad (36)$$

where z is the index of an ion component, E_0 is the electron primary energy, ε is the energy of an emitted photon, r_0 is the electron classic radius. The energy emitted by the unit of plasma volume per the unit of time within the frequency range $d\varepsilon$ is determined by the expression:

$$dQ_e = \sigma_e n_e n_i \sqrt{\frac{2E_0}{m}} f_{E_0} \qquad (37)$$

where f_{E_0} is the function of electron distribution over the values of E_0.

In Ref. [12] the expression (37) is integrated for the Maxwellian distribution for values of E_0 and ε, and, as a result, the following formula for Q_e is obtained:

$$Q_e = \frac{32}{3}\frac{z^2 r_0^2}{137}mc^2 n_e n_i \sqrt{\frac{2kT_e}{\pi m}} \qquad (38)$$

where T_e temperature of the electron component.

For approximate assessment of the bremsstrahlung gravitational emission intensity, one can use the expression (38), on replacing r_0 by r_g, calculated by the formula $r_g = 2Km/c^2$, being correspondent to a replacement of the electric charge e by the gravitational charge $m\sqrt{K}$. Then the bremsstrahlung gravitational emission intensity of the plasma electron component is determined by the expression:

$$Q_g = \beta \cdot Q_e \qquad (39)$$

where $\beta = 0.16$ for the obtained numerical value of K.

For sake of simplicity, let the region occupied by plasma be spherically symmetric one, having the radius r_0 and the radius of gravitational emission region r_{0g} determined by the condition (35). After excitation of gravitational emission, it is intensified with the growth of the internal plasma field at the expense of the increase in the number of emission elementary acts and, probably, in the size of the emission region as well. Transition from intensification to generation occurs, the increase in emission intensity is higher than its loss, and this is the case only if emission is locked up within plasma.

When creating high-temperature plasma states at laboratory conditions, they use, first of all, light gases, because maximum temperatures are accessible for them with minimum energy pumping- in. In particular, overwhelming majority of experiments on investigation of small-duration z-pinch-type pulse discharges were performed with application of deuterium [13]. Increases in the plasma temperature and density in pulse discharges are related to plasma compression by the magnetic field. The electron plasma frequency of compressed plasma is determined by the known expression $\omega_{L_e} = \sqrt{e^2 n_e/4\pi\epsilon_0 m}$. Evidently, for the emission region

having the radius r_{0g} the condition $r_{0g} < r_0$ is satisfied. Let's adopt that ω_{0g} denotes the frequency of the emitted gravitational field at $r = r_{0g}$ (i.e., along the boundary of the emission region). Then, with analogy between the impacts of electromagnetic emission and the gravitational one on plasma electrons taken into consideration, the condition for confined emission in plasma can be written as follows:

$$\omega_g(r_0) = \sqrt{e^2 n_e(r_0)/4\pi\epsilon_0 m} \tag{40}$$

The value of $\omega_g(r_0)$ is determined by graviton Compton scattering from plasma electrons at the distanced within the range from r_{0g} to r_0 , i.e., is found as a result of solution of the equations

$$d\omega_g/\omega_g = g_{rr}^{-\frac{1}{2}}\sigma_g n_e(r)dr \tag{41}$$

where σ_g is the cross-section of the graviton Compton scattering from plasma electrons, and the initial condition for ω_g has the form: $\omega_g(r_{0g}) = \omega_{0g}$.

Satisfaction of the condition (40) means presence of positive feedback in the system, i.e., this condition leads to generation of gravitational emission in plasma subject to compression. It follows from simple qualitative grounds based on analysis of the function (34) that the conditions for gravitational emission excitation in plasma are accessible to higher extent for the plasma composed of, at least, two components: $\alpha_1 z_1 + \alpha_2 z_2$, where α_1 and α_2 are the weight fractions of the light ion component (hydrogen) and the heavy one (carbon, oxygen, nitrogen). This follows from the fact that the internal plasma field intensity grows sharply when the condition $n_e > n_i$ is met; i.e. application of multi-charge ion component is required. The condition (34) determined specific size of the region where gravitational emission of plasma occurs as a result of plasma compression for a specified plasma composition. Compared to the case of purely hydrogen plasma, larger energy pumping-in to the two-component plasma is required in order to keep unchanged the values of n_e, n_i, T_e in the peripheral region as the value of α_2 is getting higher; it means that upper restriction to α_2 exists. On the other hand, it follows from Eqs. (40) and (41) that the less is α_2, the greater is the distance at which gravitational emission suppression in plasma takes place. Hence, the value of α_2 is to be such that emission suppression takes place for $r > r_{0g}$ and, at the same time, for $r \leq r_0$, leading to occurrence of restriction on α_2 from below. The role of a heavy component is not limited to producing conditions for excitation of gravitational emission but is crucial for producing conditions for confined emission in plasma, as it follows from (40) - (41). In fact, the value of σ_g is significantly greater than the similar value of the cross-section of the Compton scattering of emission on ions. This implies that the efficacy of confinement of emission in plasma as well as the conditions for its excitation are determined also by the condition $n_e > n_i$, i.e. it can take place in plasma with multy- charge ions only.

When comparing, on a base of Eq. (39), the gas kinetic pressure in plasma for the plasma parameters that satisfy the excitation conditions for gravitational emission and the pressure

of the emitted gravitational field, one can be convinced that in the time interval of an order of $t_g = 10^{-6}s$ after emission commencement these pressures are of the same order. Hence, approximately, in $t_g = 10^{-6}s$ after commencement of gravitational emission in compressed plasma the conditions needed for its confinement by the emitted gravitational field (i.e., the states of plasma hydrostatic equilibrium in the emitted gravitational field) are achieved if the latter is confined in plasma. In addition to the gravitational emission, the bremsstrahlung electromagnetic emission occurs over the entire region of compressed plasma; so only a part of the emission is confined in the region, practically, common to gravitational emission. The remaining part of the emission transforms to plasma thermal loss, and the emission spectrum corresponds to the thermal energy of the electron random motion. The confined part of the electromagnetic bremsstrahlung emission returns its energy to plasma as a result of collisions and it almost doesn't take part in plasma compression , in contrast to the emitted gravitational field having the pressure gradient that coincides precisely with the gas kinetic pressure gradient. Thus, with the satisfied conditions for excitation of gravitational emission in compressed two-or-more-component plasma, intensification and generation of the emission occur. It should be stressed that a heavier component is needed for confinement of gravitational emission.

The presented analysis allows to draw some preliminary and rather impressive conclusions as follows:

1. The fundamental property of the emitted gravitational field consists in the fact that it compresses the emitting system as the emission intensifies.

2. A system in which the gravitational emission is excited and intensified begins to operate as the quantum generator with the operation output consisting in achievement of the hydrostatic equilibrium states in the emitted gravitational field, rather than the emission release out of the system.

As is mentioned above, the well-known way for production of the dense high-temperature states in plasma is its compression by magnetic field, being especially effective if so-called "plasma focus"-type installations (PF) are applied. With application of the PF installation, the quite high energy capacity but not very stable states of plasma are produced, provided a single gas is used as the operational substance.. Addition of a heavier gas (e.g., xenon) to light operational gaseous agent results in occurrence of the compression regime, in which plasma at the final stage serves as a source of the intense X-ray emission [14]. A well-known technique of plasma generation for high atomic number elements is application of vacuum diodes with initiated break-down in the inter-electrode gap. In the discharges like this local high-temperature plasma formations (LHPF) are observed. Its nature can't be explained by pinch in magnetic lines of force. The break-down distinguishing feature (similar to the case of "PF" at the X-ray emission regime) is presence of multi-charge ions, i.e., excess of the electron component concentration compared to the ion one. In accordance with stated above, occurrence of LHPF can be explained by compression of the breakdown local regions exerted by the emitted gravitational field, because, owing to presence of multi- charge ions, the condition for reinforcement of gravitational emission is satisfied. Let's now go back to the pulse strong-current discharges in the PF-type installations. The PF regime (with xenon admixture) with

the X-ray emission occurring at the final stage can be considered as the intermediate stage between the dense plasma unstable focus regime and the stage at which reaching the state of plasma hydrostatic equilibrium in the emitted gravitational field is possible. The fact that the phenomenon like this hasn't been observed experimentally is associated with imperfection (non-optimum procedures) of the experiments concerning both the numerical ratio of light-to-heavy components and the heavy component index. Hence, in view of experimental record of the fact that the state of plasma hydrostatic equilibrium is reached in the emitted gravitational field in the pulse strong-current z- pinch-type discharges, special experiments with binary gas mixtures like *hydrogen + carbon/oxygen/nitrogen* are needed. And the optimum condition related to the plasma equilibrium state in the emitted gravitational field is, evidently, the minimum recorded integral intensity of the above-thermal portion of the electromagnetic emission under the growth of the energy pumped- up to discharge.

As for the binary mixtures, application of a composition containing 80% of hydrogen and 20% of carbon isotope $_6\mathbf{C^{12}}$ seems to be rather attractive. As is known, the nuclear transmutation chain involving carbon isotope $_6\mathbf{C^{12}}$ is called carbon cycle. The carbon cycle results in a conversion of four protons into α particle followed by 26.8 MeV energy output, i.e. the carbon chain concludes with a thermonuclear fusion reaction. This composition of the initial gas mixture is applicable in terms of accessibility of the hydrostatic equilibrium states. But the same composition is applicable for the controlled thermonuclear fusion, and this fact is to be of interest for experimenting correspondingly on pulse strong-current discharges.

4 Gravitational Emission Accompanying β -Decay

The analysis performed above shows that (provided the assumptions on the quantum properties of the gravitational impact are valid) the gravitational emission can be excited in the dense high-temperature plasma; however, emission intensification results in compression of the emitting system. Hence, as the gravitational emission increases, only sequence of the gravitation emission will be observed rather than the emission itself[4]. This fact doesn't allow to support validity of the assumption stated above and, moreover, to determine numerical characteristics of the particle stationary-state spectrum in the proper gravitational field. In terms of a principal experimental test, electrom is the most applicable object having estimation (though rough) of its stationary-state spectrum in the proper gravitational field. Also the processes exist (such as natural/artificial decay of elementary particles) that have nothing common to emission growth and where pure gravitational emission can be observed. The essence of observation for the elementary particle decay process consists in the point that (similar to the case of chemical reactions) the particles produced as a result of decay can be in an excited state with respect to the ground stationary state in its proper gravitational fields. In this respect, the β decay processes seem to be rather attractive, because its experimental recording procedures

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[4]Numerous studies devoted to recording the gravitational waves [15] aren't successful, being based on linear approximation which can't takre place in the case of large value of the emotted field gravitational constant.

are quite perfect. As is known, asymmetry of emitted electrons, considered as caused by parity nonconservation in weak interactions, is typical for β decay [16]. Nevertheless, on a base of healthy grounds, this fact should be regarded as anomaly, because in other types of fundamental interactions parity is conserved. The β asymmetry in the angular distribution of electrons is recorded in the experiments with polarised $_{27}\mathbf{Co^{60}}$ nuclei having the β spectrum which is characterised by the energies of an order of several MeV. If in the process of β decay production of excited electrons takes place, then, in addition to the decay scheme:

$$n \to p + e^- + \tilde{\nu} \tag{42}$$

also the following scheme will be realised:

$$n \to p + (e^*)^- + \tilde{\nu} \to e^- + \tilde{\gamma} + \tilde{\nu} \tag{43}$$

where $\tilde{\gamma}$ is the graviton.

The decay described by Eq. (43) is confined by the energy values of an order of $1 MeV$ (in rough approximation), with the fact taken into account that the difference between the lower excited level of the electron energy (in its proper gravitational field) and the ground state equals $\sim 130\, keV$, and by the character of the β spectrum as well. Hence, decay of the $_{27}\mathbf{Co^{60}}$ nuclei can occur with the same probability following both the scheme (42) and the scheme (43). For light nuclei (e.g.,$_1\mathbf{H^3}$) the β decay can be implemented only by the scheme (42). And it is emission of the graviton by an electron in magnetic field (with potential electron energy level splitting in magnetic field taken into consideration) can lead to the β asymmetry of the electron angular distribution. If it's not true, then for light β-radioactive nuclei the phenomenon of β asymmetry isn't observed. It means that β asymmetry of the element angular distributions, treated as parity nonconservation, is the consequence of the electron gravitational emission, and, hence, the lower boundary for β asymmetry of the β decay must exist.

5 Conclusion

1. The approximation for the Einstein relativistic gravity has been considered in which the values of the gravitational constant and the constant K for the region of elementary particle localisation are specified such way that stationary states of particles in the proper gravitational field occur, and the particle stationary states themselves are the sources of the field with the Newtonian gravitational constant G.

2. Presence of the Universe hidden energy in the form of the gravitational fields is the result of existence of the particle stationary states in the proper gravitational field, and this fact is to be taken into account in the equations of dynamical Cosmology, in accordance with significance of the hidden energy for Universe life at present.

3. Accessibility of the hydrostatic equilibrium states in the dense high-temperature plasma in the emitted gravitational field is potential consequence of the properties of quantum gravitational interaction. This fact can be examined at the experiments with pulse strong-current z-pinch-type discharges.

4. Presence of the lower coupling energy boundary for the β asymmetry of the electron angular distribution in the β decay may be considered as direct confirmation of the fact that the gravitational emission of electrons exist, in particular, in the β decay, exists.

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Can a link between asymmetry of the electron angular distribution in the β decay processes and controlled thermonuclear fusion exist?

Abstract

Comments on a manuscript of the article 'Anomalies In The β decay Processes And The Pulse Strong- Current Discharges As Consequence Of Electron Gravitational Emission'

1. The equations of the Relativistic Theory of Gravity worked out by Einstein from the variation principle are the most general form of such equations satisfying the general covariance principle. The requirement of correspondence to the Newtonian Classic Theory of Gravity has lead Einstein to the General Theory of Relativity. And that corresponds to the equations of the Relativistic Theory of Gravity with $\Lambda = 0$, while the coupling constant K is equal to the gravitational constant G. Beginning with seventies, it became clear [1] that in quantum region the numerical value of the constant G isn't compatible with the principles of Quantum Mechanics. In a number of papers [1] (also in [2]) it was shown that in quantum region the coupling constant K is more applicable, while $K \cong 10^{42}G$. So the problem of quantum-level generalisation of relativity equations was reduced to matching the numerical values of gravity constants in quantum and classic regions to each other. The article does not list the various attempts to match the quantum and classic regions within the frames of the Relativistic Theory of Gravity (including those applying scalar-tensor theories). These attempts are discussed in [1] and other more recent publications: there are no tangible results.

2. In this work the mentioned problem is being solved by the suggested theorem-like proposal followed by its rather approximate proof. This proof can be criticized for its approximate character (an exact proof in explicit analytic form is, seemingly, unobtainable due to non-linearity of equations). However, one cannot reject the suggested theorem because both on a base of physics and mathematics its result exactly matches the principles of the Relativistic Theory of Gravitation with the ones of the Quantum Mechanics. In effect, the equations of the Relativistic Theory of Gravitation which incorporate the Λ-term and coupling constant $K = 10^{42}G$ take place in quantum region. The limiting transition implied in the suggested proposal subsequently leads to the equations of the General Theory of Relativity in classic region. A semiquantum description applied in the work certainly does not always give the true picture of the quantum world, however such description does not considerably misrepresent it either. In this very case the semiquantum description is used only as an approximation to obtain estimated numerical values of energy levels of electron in the strong gravitational field. The manuscript specifically treats such approximations to be quite rough though giving picture of the subject of study. The principal points in this case are a possible existence of the energy levels of electron in the strong gravitational field and primary estimation of these levels though made by quite rough means.

3. The obtained quantum-level generalization of relativity equations logically solves the problem of a hidden mass in the Universe, which is briefly mentioned in the manuscript. Yet the quantity α_g equal to $1/3$ can be securely used for electrons only. It is known that application of the dependence $E_0 = \frac{e^2}{r_0} = mc^2$ results in the expression for the momentum $P_i = \frac{4}{3}\frac{E_0}{c^2}\nu_i$ that differs by the factor of $4/3$ from the correct expression for the momentum of a particle with mass $m = \frac{E_0}{c^2}$. This very circumstance proves the accuracy of the numerical value of $\alpha_g = 1/3$ for an electron, because the "extra" part of the energy is bound (bound part of the energy in the form of the gravitational field energy). As for other particles, at the current level of calculations one can speak only of the rough estimation of α_g value, as it is stated in the manuscript.

4. There is an unexpected conclusion that a system in which the gravitational emission is excited begins to operate as a quantum generator compressing the system by emission, rather than releasing emission out of the system. This means that the gravitational waves must not be observed in nature (except for detection of individual gravitational quanta), as it is stated in the manuscript.

5. An experimental test is suggested to check if asymmetry of the electron angular distribution in the β decay of light nuclei exists or not. It is not feasible so far to provide detailed description of the experimentally observed angular distribution in the decay of light nuclei within the frame of the considered approach. *It is stated in the paper that there will be no asymmetry of the distribution, and there is no experimental check of the contrary. As for the claim that the observed angular distribution in the β-decay of heavy nuclei "is described very well by current theories", one should note that these theories are of matching-to-observed-values character. The values of the Weinberg's angle determined from neutrino experiments resemble very much the situation with the "ultraviolet catastrophe", because the numerical values of the Weinberg's angle are simply extrapolated over the whole β-decay range. The asymmetry of the angular distribution is experimentally proved for heavy nuclei only.* It seems that it is expedient to carry out an experiment on light nuclei. And if there is no asymmetry of the angular distribution of electrons then physics will get rid of such heavy burden as the parity non-conservation in the weak interaction.

6. All these key proposals are put forward in the article. As for an experimental confirmation of the proposals being developed, it will lead to the following. On one hand, it will put the gravitational interaction into one row with the other fundamental interactions. On the other hand, it will allow to formulate a concept of quantum generators of the gravitational emission to be sources of high-energy states of matter (in case when the plasma composition allows fusion reactions between plasma components) with all the ensuing consequences (such quantum generator can also be considered the improved accelerator of elementary particles both in terms of obtainable energy level, and density of elementary particles beam, which is significant). A particular case of such states, viz. the hydrostatic equilibrium states of the dense high-temperature plasma (with absence of fusion reactions), is discussed in the article.

Thus, the applied approach puts the gravitational interaction into one row with the other fundamental interactions and eliminates the necessity to invent sophisticated tests on Quantum

Gravity (those are, as a rule, either virtually non-performable, or giving no outcome). The experimental tests on Quantum Gravity are to be performed by means of ordinary methods of elementary particles spectroscopy, because there exist the specific quantum states of elementary particles in their proper strong gravitational field, rather than the general quantum states of some abstract masses. An example of such test, being of the principle character, is the experimental check of absence of the angular distribution asymmetry in the β-decay of light nuclei.

In case the approach studied in the manuscript is correct the expediency of a huge number of researches towards the gravitational waves detection will turn to be under great doubts, as well as the expediency of designing the thermonuclear synthesis plants in the manner they are currently being designed and built. This is the very reason explaining the negative attitude towards the manuscript and the article in case it is published. Consequently the author has been pushed to let the physics community get acquainted with this manuscript by means of the Internet.